Report for 2001CO821B: Managed Groundwater Recharge for Habitat Restoration: The Development of a Biological Component to the South Platte Mapping and Analysis Program (SPMAP)

- Other Publications:
  - Garcia, Luis and Catherine Shrier, Managed Ground Water Recharge for Habitat Restoration: The Development of a Biological Component to the South Platte Mapping and Analysis Program (SPMAP), Progress Report presented at the CWRRI Advisory Council on Water Research Policy (ACWRP) annual meeting, November 5, 2001, Colorado Water Resources Research Institute, Colorado State University, Fort Collins, CO.
- unclassified:
  - Shrier, Catherine, The Development of an Expert System for Habitat Restoration Through Managed Groundwater Recharge, in Proceedings of the Fifth Annual Colorado State University Student Water Symposium, p. 14, published on-line at the Student Water Symposium website http://watersym.colostate.edu/

Report Follows:

SYNOPSIS

Project Number: 2001CO821B **Start:** 3/01
End: 2/02

Title: Managed Ground Water Recharge for Habitat Restoration: The Development of a Biological Component to the South Platte Mapping and Analysis Program (SPMAP)

Investigators: Luis Garcia

Congressional District: 4th

Focus Categories: GW, MOD, WL, WQN

Descriptors: Decision Models
Ecosystems
Geographic Information Systems
Surface-Groundwater Relationships
Wildlife Management

Problem and research objectives: The South Platte Lower River Group (SPLRG) was organized to address critical water management problems in the lower portion of the South Platte basin. SPLRG'S focus is the creation and enhancement of (1) groundwater well augmentation, (2) in-stream flows for which Colorado receives credit in a Platte Basin Endangered Species Program or ESRP, and (3) wetlands and wetland habitat for aquatic wildlife species of concern, waterfowl and other wildlife species. Under the *Tamarack Plan*, SPLRG is overseeing the development of a series of managed groundwater recharge projects to re-time river flows in order to assist with in-state water management and to provide Colorado's water contributions to the Platte River ESRP. In pilot recharge projects developed at the Tamarack Ranch State Wildlife Area, SPLRG, the Colorado Division of Wildlife (CDOW), and Ducks Unlimited (DU) have integrated habitat components into recharge facility designs, including the use of multiple recharge ponds to control temperature of return flows, the development of a live stream fed by ponds, and the development of a wetland area fed by recharge return flows (see Figure 1).

There is strong interest among private land owners in the region in developing additional recharge facilities for the *Tamarack Plan* to meet interstate water obligations, and in designing these recharge facilities both for wildlife habitat and for recharge credits for in-state water use. There is also strong interest from CDOW in continuing to restore wildlife habitat at the new recharge facilities. In 2001, the CDOW received a directive from Colorado Department of Natural Resources Director Greg Walcher to work towards the prevention of further federal threatened and endangered species listings in Colorado, and to attempt to recover currently listed species to the point where they can be de-listed. Several partnership programs with state and federal agencies and private wildlife organizations are available that can provide financial and technical assistance to private landowners who develop habitat on their property. The partnership programs include the U.S. Fish and Wildlife's Partners for Fish and Wildlife and the Natural Resources Conservation Service's Wildlife Habitat Incentive Program (WHIP) and Wetlands

Reserve Program (WRP). These partnership programs can fund 75% to 100% of the costs for construction of the recharge facilities and also provide technical expertise in the design of the facilities to maximize the potential habitat benefits. Joining private landowners with habitat partnership programs also helps the mainly agricultural users to meet the costs of developing recharge facilities for well augmentation and for the Three States Agreement.

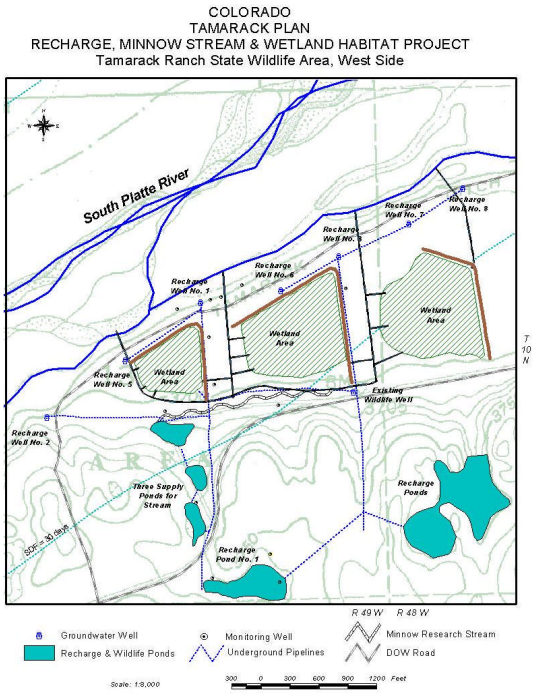

Figure 1. Tamarack Plan Recharge, Minnow Stream & Wetland Habitat Project

The goal of this research project is to develop tools that will help increase the amount of wetlands and wetlands habitat for aquatic wildlife species of concern, waterfowl, and other wildlife species in the lower South Platte River by linking recharge facility development with habitat development partnership programs. This will be accomplished primarily by:

1) developing a screening tool to identify locations for recharge facility development;
2) collecting and providing to partnership programs that develop habitat information on existing habitat development activities, species sampling activities, and CDOW wildlife management activities at State Wildlife Areas, CDOW data on riparian vegetation, and water user organization information on the location and availability of water storage and delivery facilities; and
3) facilitating a more formal relationship between habitat development partnership programs and the water user organizations by providing educational materials on habitat development on private lands targeted to the lower South Platte River of Colorado, so that the development of habitat on private lands and distribution of funds to private landowners can occur in a more coordinated manner.

A GIS-based tool is being developed to support a coordinated approach among partnership programs, CDOW, and water user organizations to the development of habitat at new managed

groundwater recharge facilities, particularly on private lands. The suitability of individual recharge sites has not been extensively modeled, but a knowledge base will be developed that will represent the expertise of engineers with experience in the development of recharge facilities. The knowledge base will be linked to user inputs and to GIS-based data that is either already available or that will be developed through this research. This tool is being developed as a biological module to the South Platte Mapping and Analysis Program (SPMAP), with 2001-2002 funding support from the Colorado Water Resources Research Institute (CWRRI) and CDOW. SPMAP is a program that is already used by water user organizations and CDOW for management and planning of well augmentation requirements in the lower South Platte.

Methodology

In developing a decision support tool that will increase habitat enhancement activities in association with managed groundwater recharge facilities in the lower South Platte, the researchers took the following steps during the 2001-2002 year of the project:

Task 1 Determine what habitat development activities can be performed in conjunction with the development of managed groundwater recharge facilities, and what steps would be required to evaluate a site for potential recharge facility and habitat development.

Several meetings were held with Colorado Division of Wildlife and Ducks Unlimited personnel, who designed the recharge and habitat demonstration project (Figure 1). Discussions concerned how those habitat components were designed and what site characteristics were necessary to support the development of those habitat components, which included: fish ponds, temperature control ponds, a live fish stream, restored sloughs, and wetland cells for waterfowl. Literature on habitat development methods was reviewed, particularly for waterfowl and fishponds. Ducks Unlimited personnel were consulted regarding their approaches to development of waterfowl habitats on private and public lands.

Northern Colorado Water Conservancy District Water Resources Engineer Jon Altenhofen was interviewed concerning parameters necessary for recharge pond development.

Task 2 Determine what partnership programs would be available for private land sites and what habitat development would be necessary for use of public wildlife lands for recharge facility development.

Several people were consulted regarding their funding programs and eligibility requirements (CDOW, USFWS, several NRCS District Managers and a couple of Ducks Unlimited South Platte Coordinators). NRCS checklists and technical reports were reviewed to ascertain management practices used by NRCS for partnership program eligibility determination.

To better understand the legal issues surrounding the development of recharge ponds on private lands, meetings were attended which addressed the legal constraints surrounding the use of State Wildlife Areas, which were purchased with federal funding support on the condition that the lands be used for wildlife-related purposes. Separate meetings were held with CDOW personnel

to discuss the constraints on uses of State Wildlife Areas and to review the CDOW draft Master Management Plan for the Tamarack Ranch State Wildlife Area.

Task 3 Identify the potential users and determine what user-inputs can be expected.

Potential uses for a computer-based tool that would be used to screen individual sites for recharge or habitat development feasibility or to support watershed-level planning for the development of multiple recharge or habitat sites were discussed in meetings with representatives from water user organizations and partnership programs. Individual landowners were contacted to determine their level of interest in partnership programs for habitat development on private lands. The amount of time and type of data that could reasonably be expected for user inputs was also assessed in the meetings with landowners.

Task 4 Identify and acquire available GIS themes containing data needed for evaluation of potential recharge and habitat development sites, and analyze GIS themes to determine whether they have appropriate scale, resolution, and accuracy for use in site or watershed scale analysis.

Available fish sampling data for the lower South Platte River was reviewed with CDOW Fish Biologist Jay Stafford. GIS themes showing locations of sampling sites with links to sampling data and photographs of sampling sites were created in cooperation with IDS GIS Specialist Dave Patterson. Meetings were held with CDOW Aquatic Section GIS Specialists to acquire data on fish sampling in the lower South Platte.

Monthly meetings of the CDOW Integrated Management Process (IMP) workgroup for the lower South Platte/Area 3 prototype were attended. The IMP workgroup had been tasked with developing "a support system to landscape management decisions and plan development by others … intended to provide a means of categorizing data and conditions and applying Geographic Information Systems to manage the data in ways that are useful to and support analysis of specific landscape conditions, support management decision making, integration of decision impacts and monitoring of selected conditions." Separate meetings were also held with members of the IMP workgroup and members of the CDOW GIS Group. Wildlife –related GIS themes were acquired with the help of the IMP workgroup.

Data and metadata from the web-based Natural Diversity Information Source (NDIS) on species and habitat in the lower South Platte were reviewed and downloaded, including data from the Colorado Riparian Mapping Project, Regional Gap Analysis Project, and Basinwide Mapping Project.

GIS themes that had been acquired were analyzed to determine whether the scale and resolution was suitable for site-specific or watershed scale analysis and whether the attribute tables associated with shapefiles contained appropriate data.

Task 5 Review alternative approaches to knowledge-base development, in order to be able to use a knowledge-based approach to link knowledge about the development of recharge facilities and habitat development with GIS-based data and site-specific user inputs.

The U.S. Forest Service's Ecosystem Management Decision Support (EMDS) system, a "knowledge-based decision support for ecological assessment" based in ArcView, was acquired and reviewed using the NetWeaver knowledge base development system. Excel-based decision support systems created by CSU Professor Darrell Fontane also were reviewed. The option of purchasing software for developing knowledge bases and inference engines versus programming simple decision support systems using Excel with Visual Basic was investigated.

Task 6 Develop prototype knowledge base for assessment of potential recharge pond sites.

A rule base for the assessment of potential recharge pond sites entered the initial stage of development. The rule base was founded upon interviews with Northern Colorado Water Conservancy District Water Resources Engineer Jon Altenhofen. The rules were evaluated to determine which parameters could be based upon GIS data or calculations in ArcView or Excel and which would require user inputs.

Principal findings and significance

Task 1 Determine what habitat development activities can be performed in conjunction with the development of managed groundwater recharge facilities, and what steps would be required to evaluate a site for potential recharge facility and habitat development.

In conjunction with DOW employees, it was determined that greater control could be exerted over the design of the pond site itself and of any habitat components to which water from the ponds would be diverted (e.g. wetland cells) than over the impacts of the return flows from the recharge ponds on the main stem of the river. The habitat potential analysis should be focused on off-stream activities rather than on impacts to the river.

Parameters necessary to evaluate sites for recharge pond development were identified. The principal parameters necessary for evaluation of potential recharge pond sites include:

> water availability; pond size, depth, and quantity and timing of water available for pond; market for recharge credits; landowner membership in water user organization; surface soils; presence of an alluvial aquifer; saturated thickness of the aquifer; depth to groundwater at the pond site; stream-depletion factor at the pond site; and whether the property is riparian or there are other landowners between the recharge pond site and the river.

Several of the necessary parameters to evaluate sites for habitat development for some types of habitat were identified. The principal parameters necessary for evaluation of habitat development include:

> surface soils; proximity to other areas managed for wildlife, including State Wildlife Areas and privately managed wildlife areas; proximity to other ponds; vegetative cover; proximity to dwellings and roads; proximity to known species populations; prior land use; use of pesticides at or near the site; landowner willingness to develop recharge facility; landowner willingness to work with

partnership programs; landowner willingness to retire land for specified period of time (e.g. 30 years), or permanently.

Task 2 Determine what partnership programs would be available for private land sites and what habitat development would be necessary for use of public wildlife lands for recharge facility development.

Several habitat partnership programs for which private lands, and particularly riparian irrigated lands, could be eligible were identified. Partnership programs identified include:

NRCS Wildlife Habitat Initiative Program (WHIP)
NRCS Wetlands Reserve Program (WRP)
NRCS Environmental Quality Improvement Program (EQIP)
USFWS Partners for Fish and Wildlife Program
Ducks Unlimited-North American Wetlands Conservation Act (NAWCA) Grant for the Lower South Platte River Wetland and Riparian Restoration Project, Phase I

It was determined that available partnership programs may change with passage of the 2002 Farm Bill. The USDA Conservation Reserve Enhancement Program (CREP) for irrigated farmlands was considered, but since the program is still under development for Colorado and is not yet available, it will not be included yet in this research effort.

Task 3 Identify the potential users and determine what user-inputs can be expected.

During meeting with Partners for Fish and Wildlife South Platte Coordinator, it was determined that the USFWS and NRCS programs work through the local Soil Conservation Districts to identify potential private landowner partners and to gain access to private lands to identify potential sites. The funding arrangements by partnership programs through soil conservation districts were discussed as well as the ways that partnership programs coordinate site visits and plan for distribution of habitat sites in conjunction with soil conservation districts. The possibility of developing a similar arrangement with the water conservation districts was explored. Types of computer-based information that would be useful to Partners for Fish and Wildlife in their planning and coordination efforts were discussed.

Several landowners who have been involved in habitat development partnerships were interviewed. They answered questions concerning incentives for participating in partnership programs, types of information that could be readily provided by landowners, and level of interest in use of computer-based tools and educational information.

The Ducks Unlimited Great Plains Regional Office was consulted to learn about information needed for strategic planning of waterfowl habitat development in the South Platte. Ducks Unlimited made it clear that they need to know legal and other constraints under which habit development will occur. Ducks Unlimited is looking for documentation of SPLRG activities and driving forces on private lands in the region.

Task 4 Identify and acquire available GIS themes containing data needed for evaluation of potential recharge and habitat development sites, and analyze GIS themes to determine whether they have appropriate scale, resolution, and accuracy.

Field records with current fish sampling data was acquired. A GIS-based tool was developed that shows the location of each sampling site with links to sampling data (species collected, number of each, sampling date, etc.) and links to photographs of the sampling site (Figure 2). CDOW fish sampling data from Aquatic Section GIS Specialists was acquired. CDOW GIS data was correlated with the current fish sampling data.

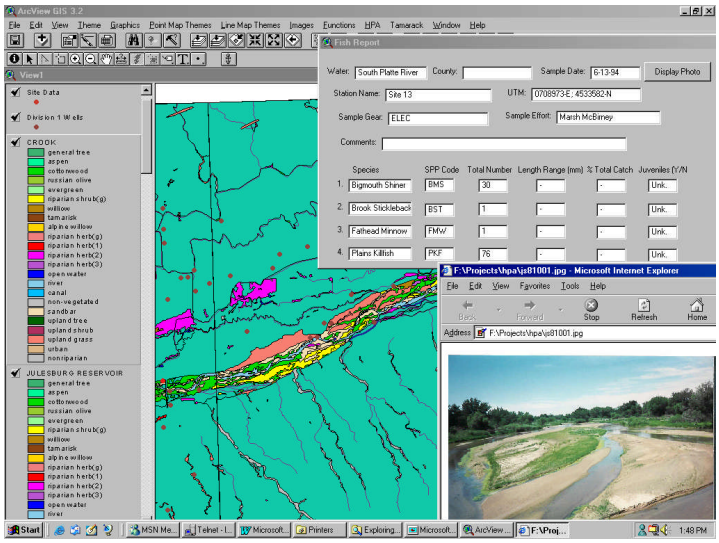

Figure 2. Habitat Potential Assessment Tool GIS themes:
South Platte hydrography, fish sampling data, riparian vegetation, photo link of sampling site

In cooperation with CDOW Integrated Management Planning Workgroup and CDOW GIS personnel, GIS data on riparian vegetation map and Natural Diversity Information Source (NDIS) maps using Basinwide Mapping vegetation data (hard copies of maps only, GIS-based data not provided by CDOW) were obtained. Meetings were held with Colorado Natural Heritage Program and CDOW personnel to determine data sources, scales, and accuracy estimates. It was determined that the Riparian Maps have the highest resolution and the highest level of accuracy but that the Riparian Mapping Program and Basinwide Mapping Program use different classification schemes to identify vegetative land cover. Also, it was ascertained that the NDIS species-vegetation affinity determinations were made using a different classification system from either the Riparian Mapping Program or the Basinwide Mapping Program. (Figure 3).

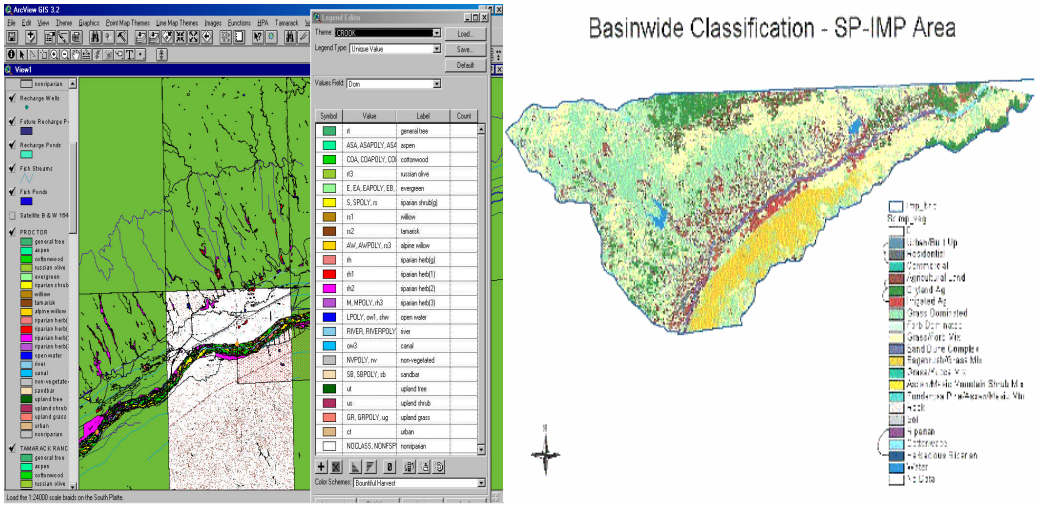

Figure 3. Images of the Riparian Mapping Program GIS-based data showing the vegetation classification scheme (left) and the Basinwide Classification map showing the Classification Scheme for the lower South Platte (SP-IMP Area) (right).

The availability of soil survey data in GIS format was investigated. Detailed soil survey data (approximately 1:24,000 scale) was discovered for Morgan County. The data was developed by a consultant for the County, was complete in the early 1990s, but was not certified by the National Rescues Conservation Service. Data for the remainder of northeastern Colorado was found only in "STATSGO" format, which are 1:250,000 scale soil survey maps, intended for state, regional, or multi-state scale analysis, with data tables from the 1980s. Hard copies of SCS/NRCS Soil Surveys and USGS Hydrologic Maps for Morgan, Logan, Sedgwick, and Washington Counties were acquired. The alternative of contracting CSU Pedology and Soils Lab to digitize Sedgwick County soils using paper soil surveys was explored. A meeting with State Soil Scientist Cameron Loerch revealed that 1:24,000 scale "SSURGO" maps are being digitized during the 2002 fiscal year for Logan, Sedgwick, and Phillips Counties.

A list of Area 3 (lower South Platte) State Wildlife Areas and a GIS-based shapefile of State Wildlife Area maps was acquired. Attribute tables for State Wildlife Areas showing the management and protected species present at each State Wildlife Area , as determined from review of MMPs and CDOW summaries of SWAs were created (Figure 4).

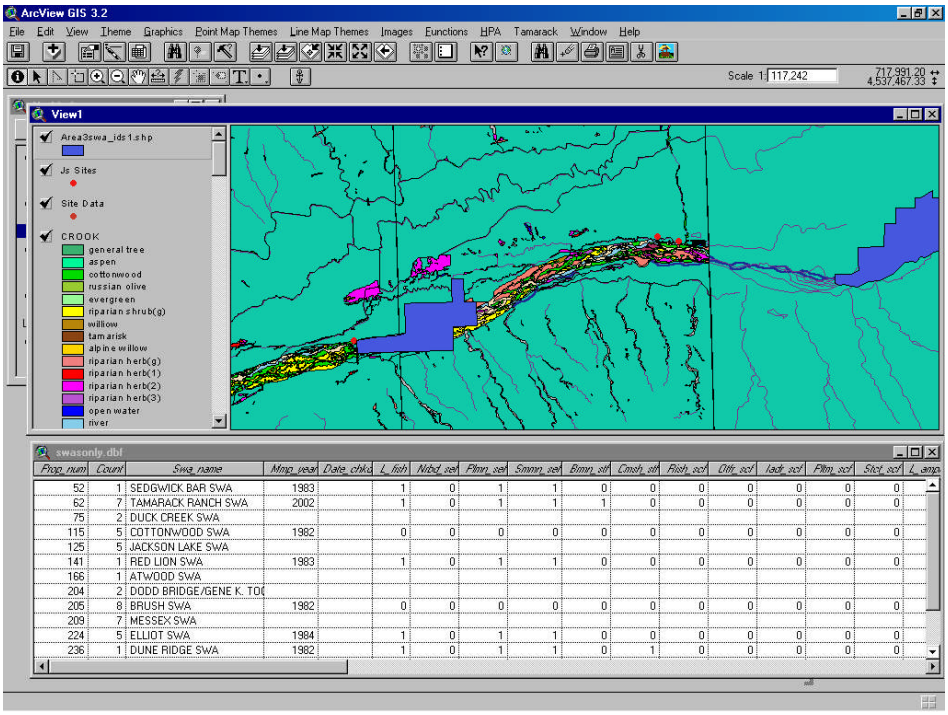

Figure 4. HPAT with GIS maps showing State Wildlife Areas and attribute table of game species and listed species, and dates of Master Management Plan

Task 5 Review alternative approaches to knowledge-base development, in order to be able to use a knowledge-based approach to link knowledge about the development of recharge facilities and habitat development with GIS-based data and site-specific user inputs.

Telephone and email interviews were conducted with the developers of EMDS and regarding the applicability of EMDS for our purposes (Figure 5). Matt Turner at the US Forest Service's Institute for Monitoring and Inventory in Fort Collins was also consulted regarding their use of NetWeaver for GIS-based data analysis. It was determined that, while EMDS can be used for fuzzy logic analysis of GIS-based data, there is limited flexibility in the output and presentation of findings of analysis if EMDS is used. Therefore, the use of an Excel-based knowledge base with links to GIS for inputs and outputs will provide greater flexibility in the development of a recharge potential assessment tool. An Excel-based knowledge-based system (KBS) shell developed by CSU Professor Darrell Fontane was evaluated, and programming of Excel-based KBS for recharge feasibility assessment began.

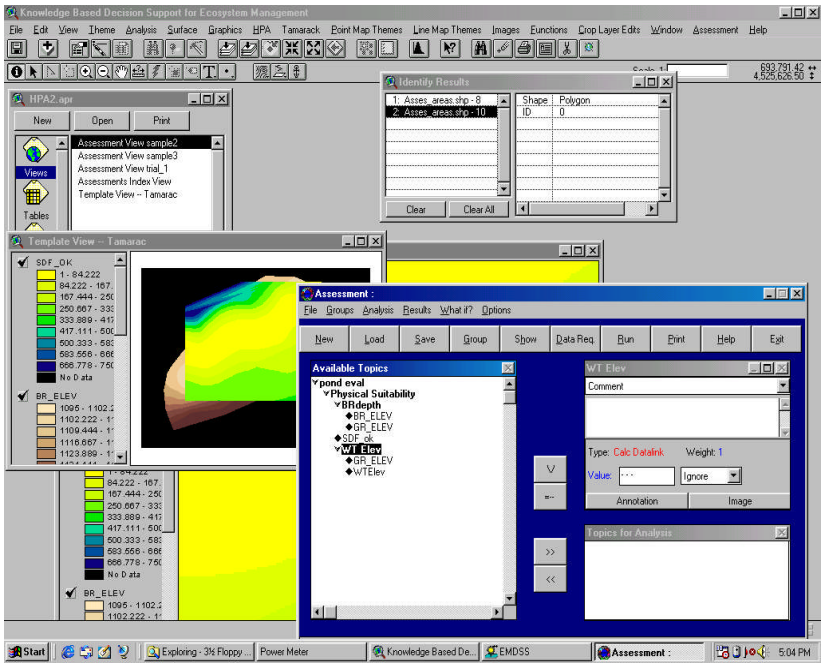

Figure 5. Sample EMDS Assessment for recharge

It was determined that the data and level of knowledge available for recharge facility development exceeds the data and level of knowledge available for habitat potential assessment. Also, investigation revealed that habitat potential assessment needs lie more in the area of watershed scale planning and improved understanding of the constraints of the various programs involved in habitat and recharge facility development.

Task 6 Develop prototype knowledge base for assessment of potential recharge pond sites.

The programming of the rule base in Excel and development of GIS themes to be linked to rule base was initiated, based on interview with Northern Colorado Water Conservancy District Water Resources Engineer Jon Altenhofen (Figure 6).

Microsoft Excel - CatSampleRule_Demo(2).xls

	A	B	C	D	E	F	G	H	I	J	K
1	Rule Based Solution Using EXCEL by Cat Shrier										
2	Based on a worksheet developed by D.G. Fontane, Oct. 2001										
3							Input Lists				
4	Input	SDF	Depth to WT	Sat Thick	Soil Type	Pond Depth	SDF	Depth to WT	Sat Thick	Soil Type	Pond De
5	Data	>=150 d	>=15 ft	>= 30 ft	Clay	0-2 ft	No Data	No Data	No Data	No Data	No Dat
6							>=150 d	>=15 ft	>= 30 ft	Sand	0-2 ft
7	Conclusions	Rules	Habitat	Recharge			150 d >x>=50 d	15 ft > x >= 5 ft	< 30 ft	Clay	>2 ft
8		1					<50 d	< 5 ft			
9		2									
10		3	Wetland	Poor							
11											
12											
13											
14											

Figure 6. Programming of the rule base